3 Clinton Lake

3.1 General Background

Clinton Lake was impounded in 1977 and reached full pool in 1980. The main threats to Clinton Lake's watershed are sedimentation, nutrients and bacterial contamination. The lake is listed on the state's 303(d) list for water quality impairment due to eutrophication and fecal bacteria. Therefore, TMDL's have been developed for the watershed to reduce nutrients, total suspended solids (TSS), and fecal bacteria, and increase dissolved oxygen. Specific TMDL targets are < 100 mg/L TSS at flows < 10 cfs, and total phosphorus (TP) < 0.1 mg/L. The Kaw Valley Heritage Alliance, formed in 1996, is a citizen-based watershed group active within the upper Wakarusa watershed. The Upper Wakarusa Watershed Restoration and Protection Strategy (WRAPS) was approved by the Kansas Department of Health and Environment during 2003. The goals and objectives of this WRAPS are to protect Clinton Lake and ultimately remove it from the 303(d) list of impaired waters.

3.1.1 Location

Clinton Lake is located approximately 6.4 km (4 miles) southwest of Lawrence, Kansas. The dam is located at river km 35.5 (river mile 22.2) of the Wakarusa River, which is a tributary of the Kansas River. The watershed encompasses the counties of Douglas, Shawnee, Osage, and Wabaunsee. Historic water quality samples sites at Clinton Lake include 3 lake, 1 outflow, and 1 inflow (Figure 3.1).

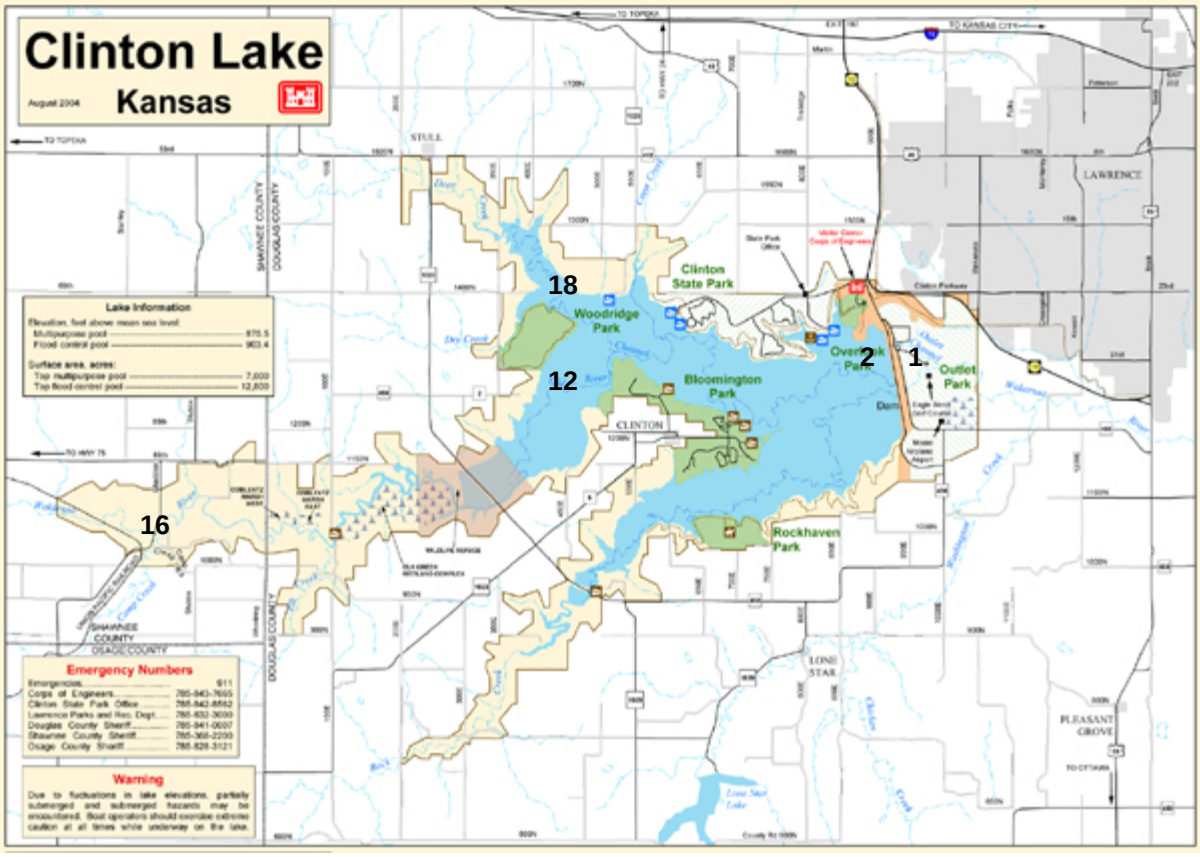

Figure 3.1. Clinton Lake area map with sample site locations and site numbers.

3.1.2 **Authorized Purposes:** Flood control, water supply, low flow supplementation, fish and wildlife conservation, and recreation.

3.1.3 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	903.5	268.8	12,891	
Multipurpose	875.5	125.3	7,006	82
Total		394.1		

Total watershed area: 367.0 sq. miles (234,880 A)
Watershed ratio: 18.22 FC / 33.5 MP

Average Annual Inflow: 186,100 acre-feet / yr (1978 – 2004)
Average Annual outflow: ? acre-feet
Sediment inflow (measured): 3,421 acre-feet (1977 – 1991)

3.2 2005 Activities

Clinton Lake was categorized as an 'ambient' lake during 2005, thus only surface samples were collected at the three lake sites. Sample collections occurred from May through September 2005, with vertical profiles measured at the three lake sites during August. Clinton Lake staff (OF-CL) providing field assistance with the WQP during 2005 included Kipp Walters and Dave Rhoades. Lew Ruona, OF-CL Operations Manager, provided technical insight and background knowledge on Clinton Lake and the Upper Waukarusa watershed. I met twice with the Upper Wakarusa WRAPS group during 2005, and presented a poster presentation on historic water quality data for a rural committee meeting (2 November 2005).

3.3 2005 Data

Comparative historic data consists of monthly (April – September) data collected from 1996 through 2005.

3.3.1 Inflow

No inflow samples were collected from the Clinton Lake watershed during 2005. Historically, nutrient concentrations (nitrogen and phosphorus) are most variable at this site due to influences of runoff events within the watershed. Please see comments for lake sites below on specific parameters.

3.3.2 Lake

Total nitrogen (TN) and total phosphorus (TP) median concentrations and chlorophyll a values indicate that Clinton Lake is eutrophic. Monthly and annual variability in total

nitrogen is evident at all sites. Median concentrations range from 0.7 – 1.0 mg/L (Figure 3.2), which is above the proposed EPA nutrient criteria value of 0.36 mg/L total nitrogen. The measured values are typical for lakes within this region. Median total phosphorus concentrations (0.06 – 0.13mg/L) for all sites exceed the proposed EPA nutrient criteria value (0.02 mg/L)(Figure 3.3). The median TP values only meet the WRAPS target value < 0.1 mg/L at the dam and outflow sites. The TP concentrations are typical of our district lakes.

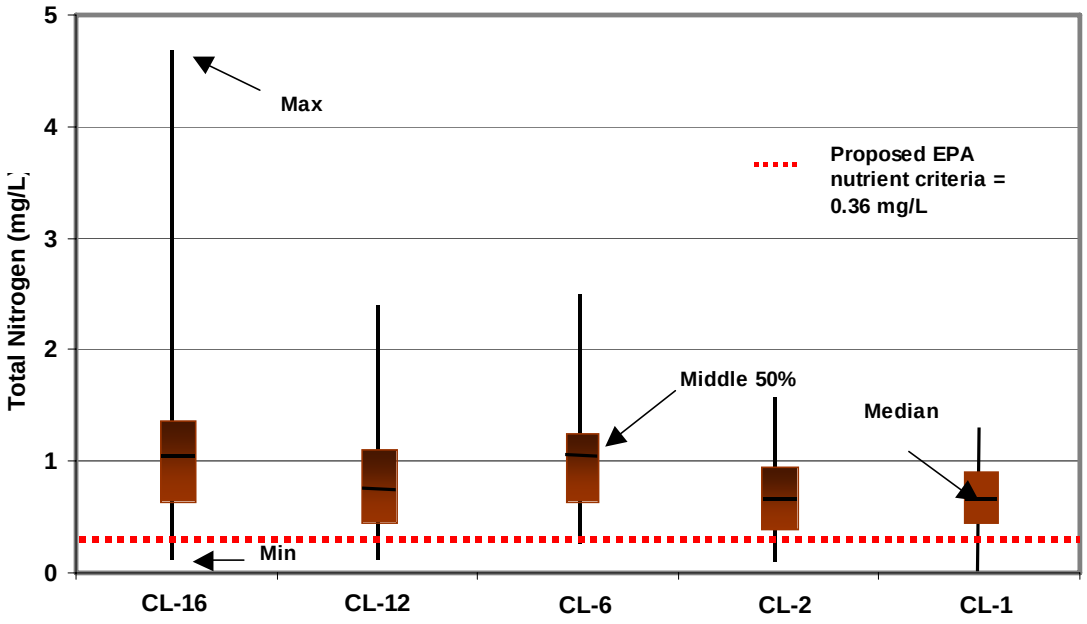

Figure 3.2. Box plots of surface water sample total nitrogen concentrations measured at lake sites from 1996 through 2005 at Clinton Lake.

The ratio of TN:TP can be used as a surrogate to determine the dominant algal community within a waterbody. Ratios ≥ 20:1 are indicative of desirable algal communities, whereas ratios ≤ 12:1 are indicative of bloom-forming cyanobacteria (blue green algae). As would be expected, there is high monthly and annual variability in the TN:TP ratio at all sites; see Figure 3.4 as an example at Site 2. Median TN:TP ratios at all three lake sites are < 12, indicating the lake is at risk for cyanobacteria blooms (Figure 3.5).

Mean chlorophyll a concentrations ranged from 17 – 18 ug/L during August and September. Secchi depth measured during August indicated water clarity was very limited in Rock Creek (0.3 m), moderately clear in the Wakarusa arm (site 12 = 1.2 m), and clear at the tower site (1.8 m).

Atrazine samples were not collected during 2005. Between 1996 and 2004, median atrazine concentrations (1.3 – 1.7 ug/L) are less than the EPA drinking water maximum contaminant level of 3 ug/L (Figure 3.6). However, individual samples measured during that time period are significant enough to exceed the MCL. Figure 3.7 depicts the

individual sample concentrations measured by date at Site 16 (Wakarusa River inflow site).

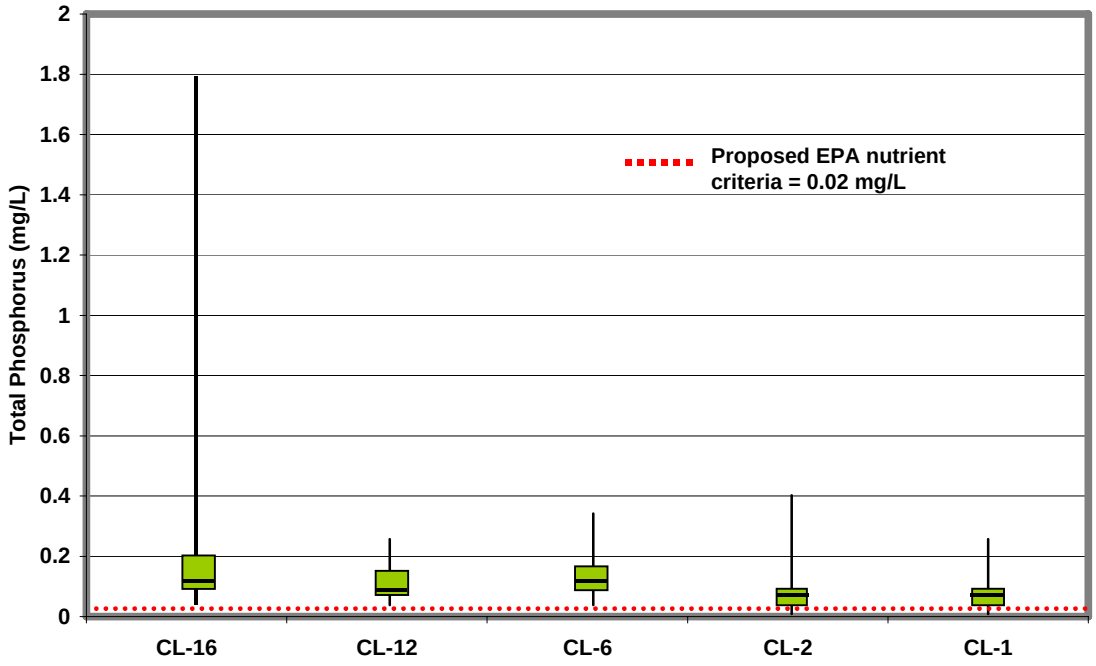

Figure 3.3. Box plots of surface water sample total phosphorus concentrations measured at lake sites from 1996 through 2005 at Clinton Lake.

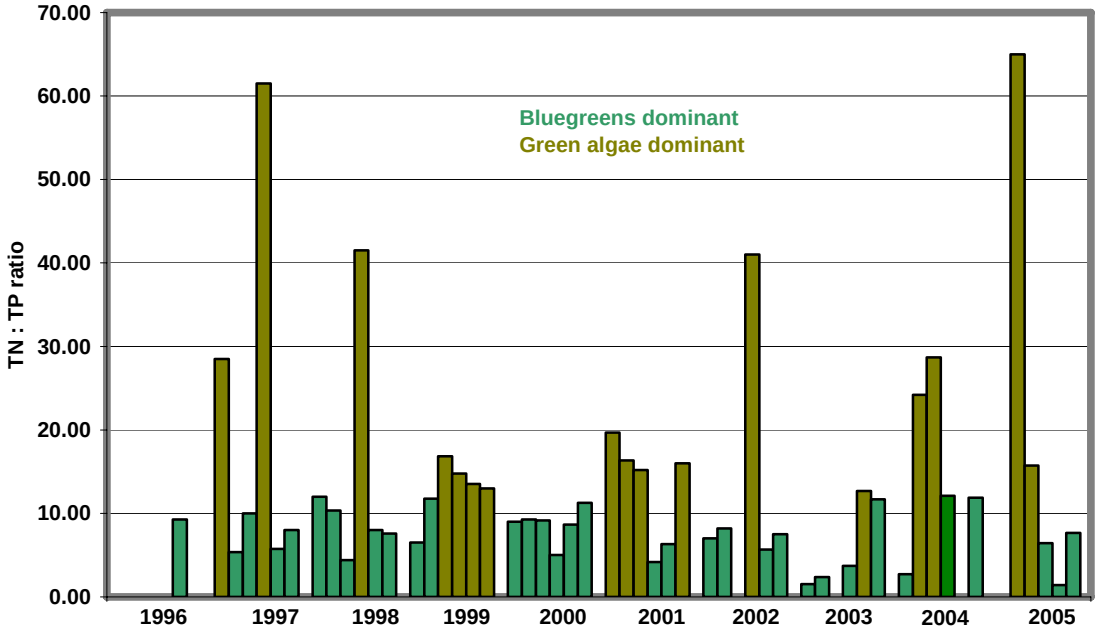

Figure 3.4. Graph of total nitrogen : total phosphorus ratio (TN:TP) by sample at Site 2 of Clinton Lake from 1996 through 2005.

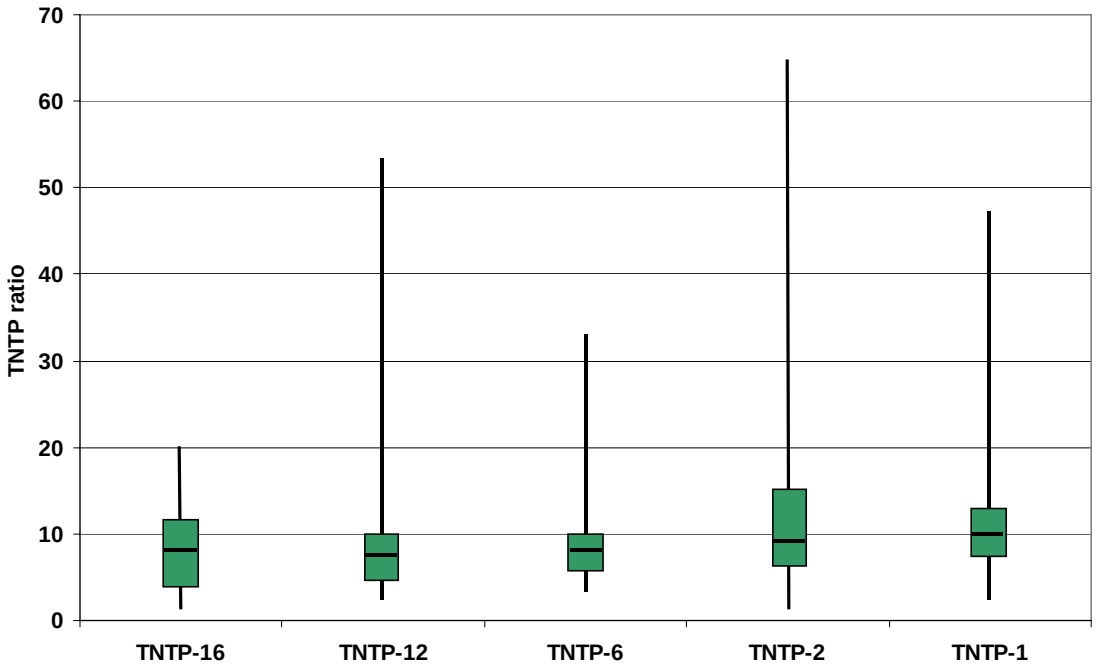

Figure 3.5. Box plots of total nitrogen : total phosphorus (TN:TP) by site from 1996 through 2005 at Clinton Lake.

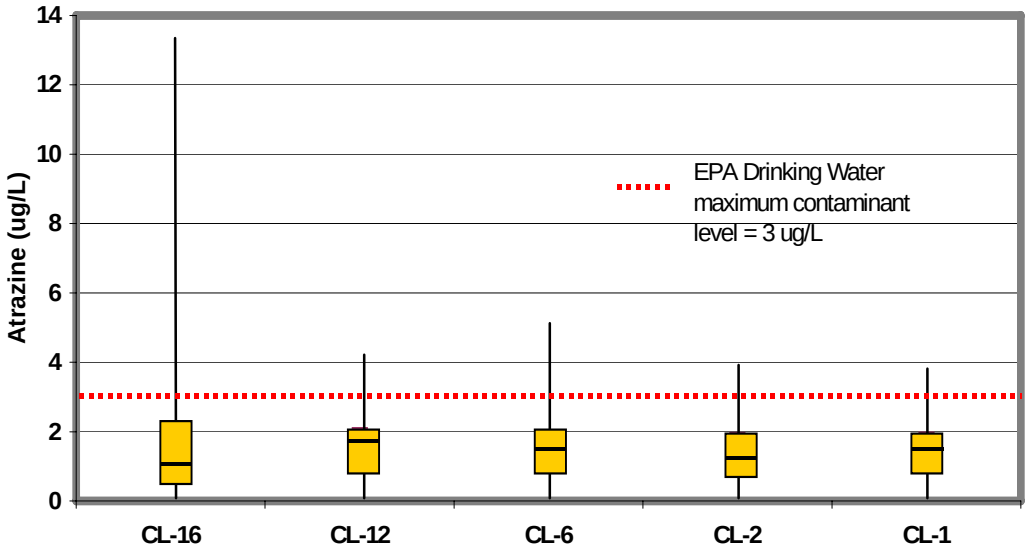

Figure 3.6. Box plots of surface water sample atrazine concentrations measured at lake sites from 1996 through 2005 at Clinton Lake.

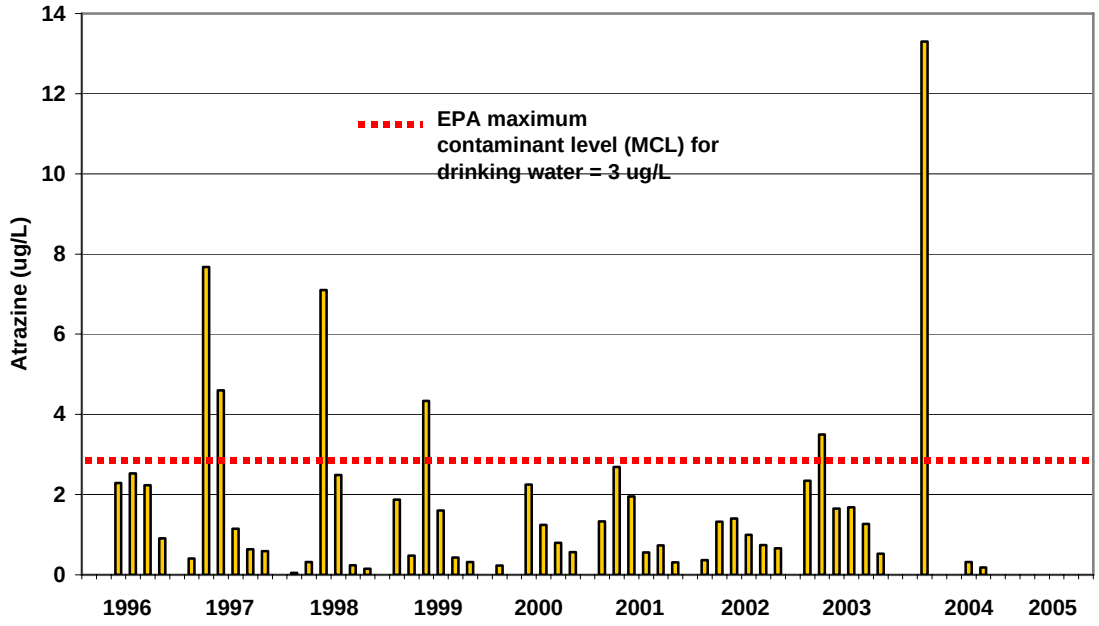

Figure 3.7. Atrazine concentrations by sample date collected at Site 16 (Wakarusa River) inflow to Clinton Lake from 1996 through 2004.

A single vertical profile was recorded during the 10 August sampling trip. Parameters included temperature, dissolved oxygen, pH, conductivity, and turbidity. Based on this profile, the lake was strongly stratified both thermally and chemically between a depth of 3 – 4 m (Figure 3.8).

Fecal bacteria samples were collected from three locations at the Corp swimming beach prior to three major holidays (Memorial Day, July 4th, and Labor Day). All samples were well within compliance limits of 732 colonies / 100 ml for a single sample (Figure 3.9).

3.3.3 Outflow

No outflow samples were from collected from Clinton Lake during 2005.

3.4 Future Activities and Recommendations

Sampling activities for 2006 will include continuation of monthly 'ambient' monitoring from May through September, as well as conducting at least one summer vertical profile at each of the three lake sites. In addition, we will monitor bluegreen algae vertical distribution within the water column at the lake during the summer and compare to data collected by the University of Kansas (Andy Dzilowski, KBS). Fish tissue contaminant analysis is recommended during 2006 or 2007, and such sampling will be coordinated with Kansas Parks and Wildlife (KPW), Kansas Department of Health and Environment (KDHE), and EPA Region 7 laboratory. Another contaminant group of interest for Clinton Lake are Polynuclear Aromatic Hydrocarbons (PAHs). PAHs are typical

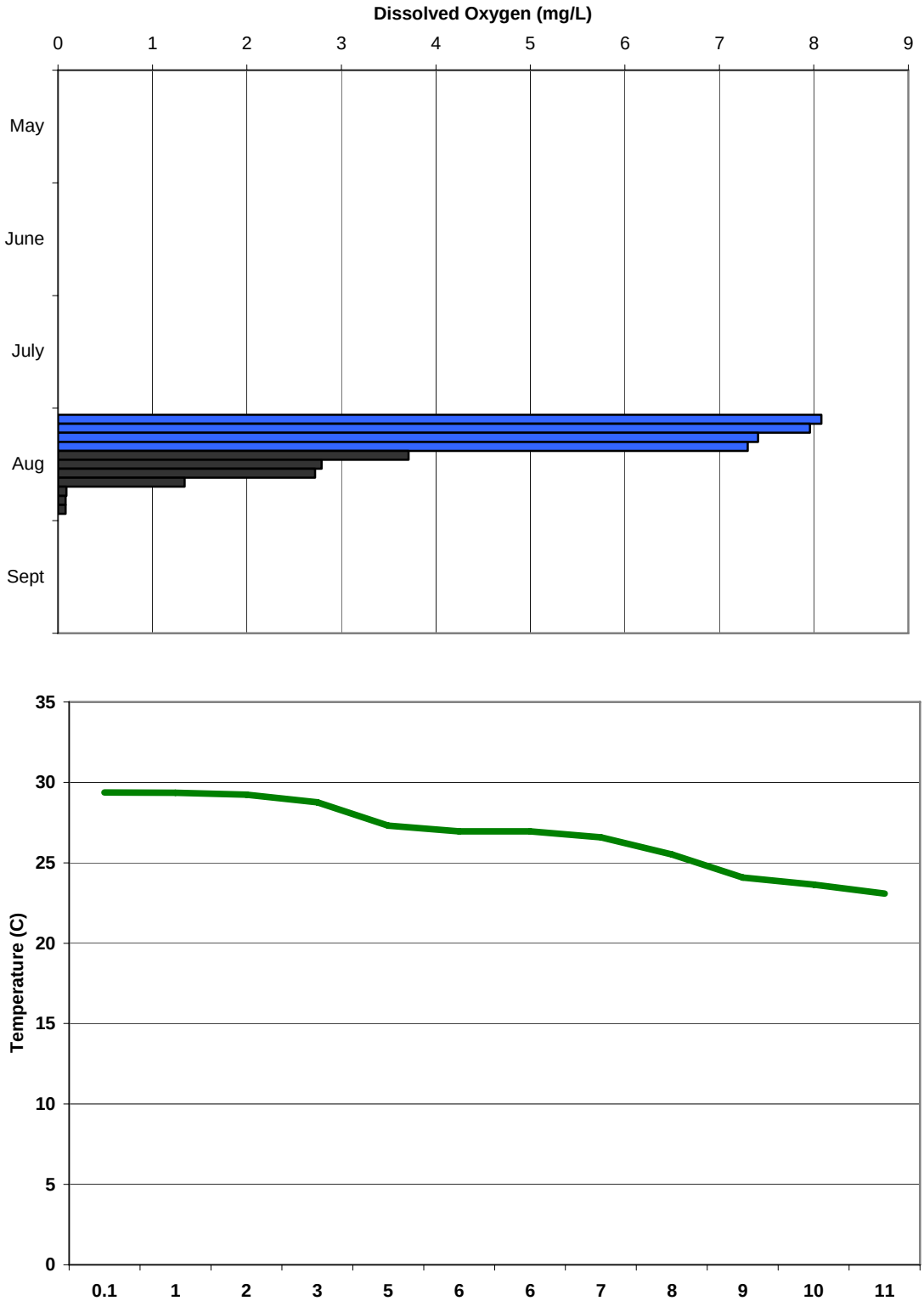

Figure 3.8. Dissolved oxygen concentration (mg/L) histogram and temperature (C) plot from a vertical profile recorded at Site 2 during August, 2005 at Clinton Lake.

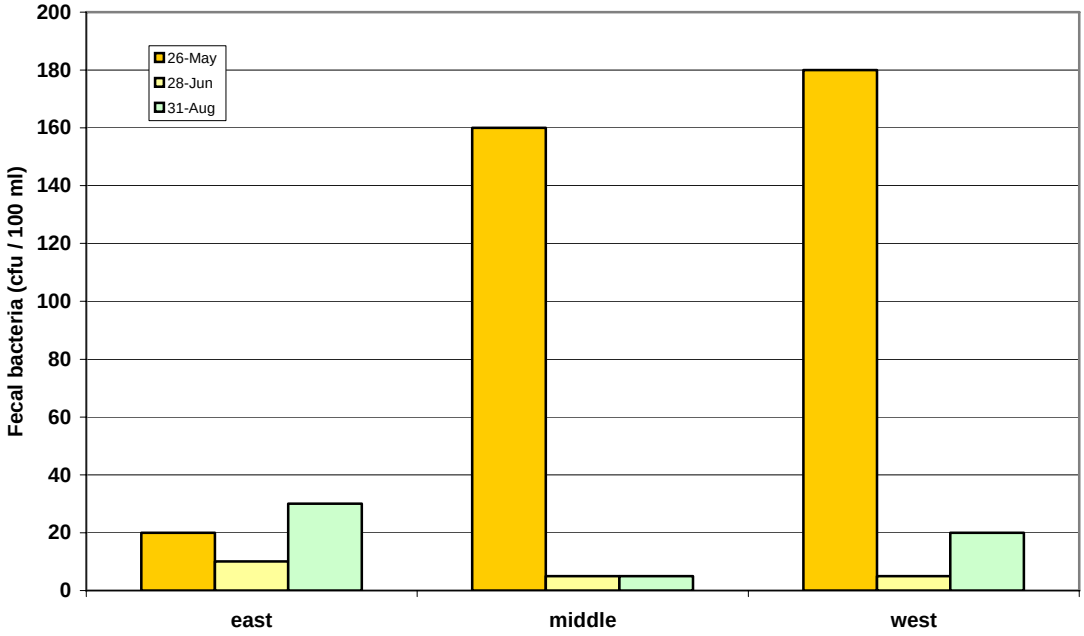

Figure 3.9. Fecal bacteria (E coli) colonies per 100 ml samples collected from three sites at the swimming beach prior to Memorial Day, July 4th, and Labor Day during 2005 at Clinton Lake.

components of asphalt, fuels, oils, and greases. These compounds enter receiving waters from atmospheric deposition, stormwater runoff, as well as through industrial and wastewater treatment discharges. They do not dissolve, but will attach to particulate material and eventually settle out to the substrate.